P-II (1+1+1) H / 18 (N)

2018

PHYSICS (Honours)

Paper Code : IV-A

[New Syllabus]

Full Marks : 15 Time : Thirty Minutes

Important Instructions for OMR Sheet

1. Write / Fill your correct Subject Name, Subject Code & Paper Code in the space provided on the top of the OMR sheet (Subject Codes are given on the back of the OMR sheet & Paper Code in the Question Paper.)
2. Write / Fill your Name, Roll number, Registration number, Regn. Session, Exam Date and Exam Session in the space provided on the OMR Sheet.
3. Each item has four alternative responses marked (A), (B), (C) and (D). You have to darken the circle as indicated below on the correct response against each item.
4. Your responses to the items are to be indicated in the **OMR Sheet given inside the Paper Booklet only**. If you mark at any place other than in the circle in the OMR Sheet, it will not be evaluated.
5. If you write your Phone Number in the OMR Sheet or use abusive language or employ any other unfair means, you will render yourself liable to disqualification.
6. You have to return the OMR Sheet to the invigilators at the end of the examination compulsorily and must not carry it with you outside the Examination Hall.
7. **Use only Blue/Black Ball point pen. Use of any mobile phone, calculator or log table etc. in examination hall, is prohibited.**

OMR Sheet-এর জন্য জরুরী নির্দেশাবলী

১। OMR Sheet এর নির্দেশিত স্থানে সঠিক Subject Name, Subject Code এবং Paper Code লিখতে/পূরণ করতে হবে। OMR Sheet এর পিছনের পাতায় Subject Code গুলি দেওয়া আছে এবং Paper Code টি প্রশ্নপত্রে উল্লেখ আছে।

২। OMR Sheet এর নির্দেশিত স্থানে Name, Roll number, Registration number, Regn. Session, Exam date এবং Exam Session লিখতে/পূরণ করতে হবে।

৩। প্রতিটি প্রশ্নে চারটি করে সম্ভাব্য উত্তর, যথাক্রমে (A), (B), (C) এবং (D) করে দেওয়া আছে। পরীক্ষার্থীকে সঠিক উত্তরের গোল ঘরটি নীল/কালো কালিতে পূরণ করতে হবে।

৪। সঠিক উত্তর কেবলমাত্র উত্তর পত্র অর্থাৎ OMR Sheet-এর নির্দিষ্ট স্থানে গোল ঘর পূরণ করেই দিতে হবে। অন্য কোনো উপায়ে দেওয়া উত্তরের মূল্যায়ন হবে না।

৫। পরীক্ষার্থীর ফোন নম্বর OMR Sheet এর কোনো অংশে লেখা যাবে না। কোনোরূপ অবাঞ্ছিত শব্দ লেখা বা দুর্নীতির আশ্রয় নিলে পরীক্ষার্থী নিজেই তার জন্য দায়ী থাকবে।

৬। পরীক্ষা শেষে উত্তর পত্র (OMR Sheet) সংশ্লিষ্ট তত্ত্বাবধায়কের নিকট জমা দিয়ে পরীক্ষা কেন্দ্রের বাইরে বেরোতে হবে এবং কোনোভাবেই পরীক্ষা কেন্দ্রের বাইরে OMR Sheet টি আনা যাবে না।

৭। **শুধুমাত্র নীল/কালো বল পয়েন্ট কলম ব্যবহার করতে হবে। পরীক্ষাকক্ষে মোবাইল ফোন, ক্যালকুলেটর অথবা লগ-টেবিল ইত্যাদি ব্যবহার নিষিদ্ধ।**

Answer *all* the questions in OMR sheet.

Choose the correct answer.

Each question carries $1\frac{1}{2}$ marks.

1. A convex lens of focal length 24 cm (refractive index of the material of the lens is 1.50) is totally immersed in water (refractive index = 1.33). The focal length of the lens in water will be —

   (A) 24.0 cm

   (B) 47.0 cm (approx.)

   (C) 70.5 cm (approx.)

   (D) 93.75 cm (approx.)

2. The distance between two points in a medium is 4.0 cm, while the corresponding optical path between those two points is 6.0 cm. Then, the speed of light in the said medium is —

   (A) $10^8\ ms^{-1}$

   (B) $2\times10^8\ ms^{-1}$

   (C) $3\times10^8\ ms^{-1}$

   (D) $4\times10^8\ ms^{-1}$

3. The object glass of a telescope is an achromat of focal length + 90 cm. If the dispensive powers of the two component lenses are 0.024 and 0.036, their focal lengths (with proper sign) are —

   (A) + 30 cm and – 45 cm

   (B) + 45 cm and – 30 cm

   (C) + 90 cm and – 45 cm

   (D) + 10 cm and – 15 cm

Turn Over

4. Visible light ranges from 4.0×10^{14} Hz to 7.5×10^{14} Hz. Taking $C=3\times10^8 ms^{-1}$, the coherence length for this white light would be —

   (A) $8.58\times10^{-5} m$

   (B) $8.58\times10^{-6} m$

   (C) $8.58\times10^{-7} m$

   (D) None of the above

5. A biprism is placed 5.0 cm from a slit illuminated by light of wavelength 600 nm. The fringe-width on a screen placed at a distance of 75.0 cm from the biprism is 9.6×10^{-2} cm. The distance between the two coherent sources is —

   (A) 0.05 cm

   (B) 0.06 cm

   (C) 0.04 cm

   (D) 0.047 cm

6. A plane diffraction grating has 2100 lines per cm. Light of wavelength 500 nm is incident normally on the grating and undergoes diffraction. The highest order of principal maximum visible in the diffraction pattern is —

   (A) 4

   (B) 5

   (C) 10

   (D) 9

7. The Fraunhofer diffraction pattern of a single slit (of width 1.2×10^{-4}cm) illuminated by monochromatic light of wavelength 600 nm is obtained. The half angular width of the central bright maximum will be —

(A) 60°

(B) 30°

(C) 5°

(D) 0.5°

8. When operated between cut-off and saturation, a transistor behaves like a —

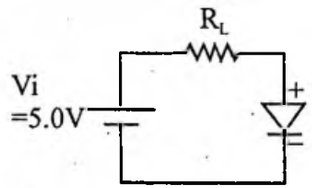
(A) linear amplifier

(B) variable resistor

(C) variable capacitor

(D) switch

9. Consider a diode in series with a power supply of 5.0 V and a load resistance R_L (see fiture). Assuming diode cut-in voltage to be 0.6V and forward resistance 50Ω, the value of R_L required for the current through the diode to be 10.0 mA, would be —



(A) 440Ω

(B) 450Ω

(C) 390Ω

(D) 490Ω

Turn Over

10. In a transistor operating in CE mode, a constant base current of 20 μA flows. The collector current changes from 3.0 mA to 3.5 mA when the collector - emitter voltage changes from 6.0 V to 12.0 V. The output resistance of the transistor is —

(A) 12.0 $k\Omega$

(B) 6.0 $k\Omega$

(C) 2.0 $k\Omega$

(D) 1.2 $k\Omega$

P-II (1+1+1) H / 18 (N)

2018

PHYSICS (Honours)

Paper Code : IV-B

[New Syllabus]

Full Marks : 55 Time : Three Hours Thirty Minutes

The figures in the margin indicate full marks.

Answer *five* questions taking at least *one* from each group.

Any kind of calculator may be used.

Group - A

[Geometrical Optics]

1. (a) Using Fermat's principle, show that all the rays passing through one focus of an elliptic reflector pass through the other focus after reflection. 2

(b) Show that for refraction at a concave spherical surface (separating glass-air medium), the distance of the object should be greater than three times the radius of curvature of the refracting surface for the image to be real. Take $n_{glass} = 1.50$. 4

(c) How would you combine two prisms of different material so that the combination would produce deviation but no dispersion ?

Apply the principle to calculate the angle of the flint glass prism which, when combined with a crown glass prism of 10°, produces deviation but no dispersion. Find also the total deviation produced. Given : n_v, n and n_r are 1.523, 1.517 and 1.514 respectively for crown glass and those for the flint glass are respectively 1.664, 1.650 and 1.644. 2+3

2. (a) What are the advantages of a Ramsden's eye-piece over a Huygens' eye-piece ? 2

Turn Over

(b) Obtain an expression for the magnifying power of a magnifying glass for normal vision. 4

(c) A convex lens made up of a material of refractive index 1.5 has radii of curvature 2.0 cm and –2.0 cm. If the thickness of the lens is also 2.0 cm, find the system matrix and the positions of the focal points (as measured from the principal points). 5

Group - B

[Physical Optics]

3. (a) Compare the Lloyd's mirror and the biprism fringes. 2

(b) Explain the formation of Newton's rings. Prove that the diameters of the dark rings are proportional to the square root of natural numbers. Are the fringes localised or non-localised ? 2+3+1

(c) In Newton's ring experiment, the radius of the 10th dark ring is found to be 4.0 mm when there is air between the convex lens and the glass plate. However, when air is replaced by a liquid, the radius of the ring shrinks from 4.0 mm to 3.3 mm. Find the refractive index of the liquid. 3

4. (a) A plane wavefront of monochromatic light undergoes diffraction in a double slit. Analyse the diffraction pattern observed. What do you mean by missing orders of spectral lines ? 6+1

(b) The above diffraction pattern is observed in the focal plane of a convex lens of focal length 50.0 cm. The wavelength of the incident light is 500 nm. The distance between the two maxima adjacent to the maximum of zero order is 0.5 cm and the 4th order maximum is missing. Find the width of each slit and the distance between their centres. 4

5. (a) Compare the actions of a zone plate and a convex lens. 3

(b) Define dispersive power of a plane diffraction grating. A grating which has 4000 lines per cm is used at normal incidence. Calculate the dispersive power of the grating in the 3rd order spectrum in the wavelength region of 500 nm. 1+2

(c) Discuss the working principle of a Michelson's interferometer. Under what conditions are circular and straight fringes produced by it ? 3+2

6. (a) What do you mean by antireflection coating ? Discuss the theory behind it. 2+2

(b) What should be the thickness of a non-reflecting layer to be deposited on glass surface corresponding to light of wavelength 600 nm ? Refractive index of the layer is 1.35. 2

(c) State Rayleigh's criterion of resolution of spectral lines. The separation between the two headlights of a car is 1.22m. Calculate the greatest distance from which a normal human eye can distinguish the two headlights. The diameter of the eye-pupil is 5.0 mm and the wavelength of light is 500 nm. 1+2

(d) Explain the formation of colour in a thin film. 2

Group - C

[Electronics - I]

7. (a) How is the depletion region formed in a $p-n$ junction diode ? Explain the variation of its width with biasing. The barrier potential across a $p-n$ junction diode cannot be measured simply by placing a voltmeter across the diode terminals. Why ? 2+1+1

(b) The reverse saturation current at 27.°C of a $p-n$ junction Ge diode is $5.0\,\mu A$. Find the voltage to be applied across the junction to obtain a forward current of 50.0 mA. Also calculate the static and dynamic resistance of the diode. Take the electronic charge (e) as 1.6×10^{-19} Coulomb and Boltzmann's constant (k) as 1.38×10^{-23} JK^{-1}. 4

(c) What is meant by load regulation by a Zener diode ? Define percentage regulation. 2+1

Turn Over

8. (a) What do you mean by the collector to base leakage current (I_{CBO}) in a transistor ?

The common-base current gain in an n-p-n transistor is 0.98. If $I_{CBO} = 12.5\,\mu A$, determine the base current and the collector current for an emitter current of 2.0 mA. Assume the formula you need 1+2

(b) What is thermal runaway of a transistor ? 2

(c) Convert the decimal number 2475 to a hexadecimal number. 2

(d) Prove the Boolean identity : $(A+B)(\bar{A}+C) = AC + \bar{A}B$. 2

(e) Draw the circuit symbol of an XOR gate and write down its truth table. 2

P-II (1+1+1) H / 18 (N)

2018

PHYSICS (Honours)

Paper Code : V-A

[New Syllabus]

Full Marks : 15 Time : Thirty Minutes

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OMR Sheet-এর জন্য জরুরী নির্দেশাবলী

১। OMR Sheet এর নির্দেশিত স্থানে সঠিক Subject Name, Subject Code এবং Paper Code লিখতে/পূরণ করতে হবে। OMR Sheet এর পিছনের পাতায় Subject Code গুলি দেওয়া আছে এবং Paper Code টি প্রশ্নপত্রে উল্লেখ আছে।

২। OMR Sheet এর নির্দেশিত স্থানে Name, Roll number, Registration number, Regn. Session, Exam date এবং Exam Session লিখতে/পূরণ করতে হবে।

৩। প্রতিটি প্রশ্নে চারটি করে সম্ভাব্য উত্তর, যথাক্রমে (A), (B), (C) এবং (D) করে দেওয়া আছে। পরীক্ষার্থীকে সঠিক উত্তরের গোল ঘরটি নীল/কালো কালিতে পূরণ করতে হবে।

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৬। পরীক্ষা শেষে উত্তর পত্র (OMR Sheet) সংশ্লিষ্ট তত্ত্বাবধায়কের নিকট জমা দিয়ে পরীক্ষা কেন্দ্রের বাইরে বেরোতে হবে এবং কোনোভাবেই পরীক্ষা কেন্দ্রের বাইরে OMR Sheet টি আনা যাবে না।

৭। **শুধুমাত্র নীল/কালো বল পয়েন্ট কলম ব্যবহার করতে হবে। পরীক্ষাকক্ষে মোবাইল ফোন, ক্যালকুলেটর অথবা লগ-টেবিল ইত্যাদি ব্যবহার নিষিদ্ধ।**

Answer *all* the questions in OMR sheet.

Choose the correct answer.

Each question carries $1\frac{1}{2}$ marks.

1. The equation of state of a system is given by $P = f(v)T$, symbols being usual. As V increases, the entropy S of the system will —

   (A) always increase

   (B) always decrease

   (C) sometimes increase and sometimes decrease

   (D) remain constant

2. If the critical temperature for H_2 gas is $-251°C$, the temperature of inversion will be —

   (A) 148.5°C

   (B) –269.74°C

   (C) –124.5°C

   (D) 421.5°C

Turn Over

3. In Joule-Thomson effect, it is found that for a small pressure difference $\Delta P = P_f - P_i$, the temperature difference is given by $\Delta T = \frac{V}{C_p}(\alpha t - 1)\Delta P$, where $\alpha = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_P$. For n moles of an ideal gas, the said temperature difference will be —

   (A) $\frac{V}{C_P}(\alpha T - 1)\Delta P$

   (B) $\frac{V}{C_P}(1 - \alpha T)\Delta P$

   (C) $\frac{V}{nR}(\alpha T - 1)\Delta P$

   (D) Zero

4. If 100 gm of water at 40°C is mixed with 100 gm of water at 20°C, the final temperature of the mixture will be 30°C, provided no heat is lost elsewhere. So, the net heat change of the universe (ΔQ) is zero. Then, the net change in entropy of the universe (ΔS) will be —

   (A) zero ;

   (B) greater than zero (i.e. positive) ;

   (C) less than zero (i.e. negative) ;

   (D) sometimes positive and sometimes negative

5. In a first-order phase transition, the following statement is true —

(A) The Helmholtz free energy (F) remains constant.

(B) The Gibbs' free energy (G) remains constant.

(C) The enthalpy (H) remains constant

(D) Both F and G remain constant.

6. The magnetic flux (in milli-weber) associated with a coil in a magnetic field changes with time t (in sec) by the following equation : $\phi = \frac{t^3}{3} + \frac{t^2}{2} + 4t$. The induced e.m.f. in the coil when $t = 2$ sec will be —

(A) 10 volt;

(B) 1.0 volt;

(C) 0.1 volt

(D) 0.01 volt

7. A series LR circuit is fed by an alternating e.m.f. $E = E_0 \sin wt$, terms being usual. The value of the ohmic resistance (R) is so adjusted that the circuit delivers maximum power. In that case, the power factor has a value —

(A) $\frac{1}{\sqrt{2}}$

(B) 1.0

(C) 0

(D) $\frac{1}{2}$

Turn Over

8. In a material, the magnetisation is $\vec{M} = \left(2y\hat{i} - 3x\hat{k}\right) Am^{-1}$. The corresponding bound current density $\left(\vec{J}_M\right)$ is —

(A) $\left(3\hat{j} + 2\hat{k}\right) A.m^{-2}$

(B) $\left(2\hat{k} - 3\hat{j}\right) A.m^{-2}$

(C) $\left(3\hat{j} - 2\hat{k}\right) A.m^{-2}$

(D) $\left(3\hat{i} - 2\hat{j}\right) A.m^{-2}$

9. In an ideal step-up transformer, the secondary voltage is greater than the primary voltage. For such a transformer, the following statement is true —

(A) The secondary current is greater than the primary current so that there is a net gain of power.

(B) The secondary current is less than the primary current so that power remains conserved.

(C) The secondary current is less than the primary current so that there is a net loss of power.

(D) The primary and the secondary currents are always equal so that there is always a gain of power.

10. A uniform wire of length 'l'm is bent into a circle. The current flowing through the wire is I amp. The magnetic induction at the centre of the circle will be —

(A) $\frac{\mu_0 I}{2l}$ tesla ;

(B) $\frac{\pi\mu_0 I}{2l}$ tesla ;

(C) $\frac{\pi\mu_0 I}{l}$ tesla ;

(D) $\frac{2\pi\mu_0 I}{l}$ tesla ;

———————

Turn Over

2018

PHYSICS (Honours)

Paper Code : V-B

[New Syllabus]

Full Marks : 55 Time : Three Hours Thirty Minutes

The figures in the margin indicate full marks.

Answer *five* questions, taking at least *two* from each group.

(Any kind of Calculator may be used)

Group - A

[Thermodynamics]

1. (a) What do you mean by 'heat', 'work' and 'internal energy'? Distinguish among them. 3

(b) Consider the infinitesimal quantity $dF = \left(x^2 - y\right)dx + xdy$. Is dF a perfect differential ? If we define $dG = \frac{dF}{x^2}$, will dG be a perfect differential ? 2

(c) Show that the minimum pressure that can be attained by one mole of an ideal gas during a process governed by the relation $T = T_0 + \alpha V^2$ is $2R\sqrt{\alpha T_0}$, where α and T_0 are positive constants. 3

(d) Prove that, working between the same temperature limits, no irreversible engine can be more efficient than a reversible one. 3

2. (a) Prove analytically that work done by a system (dW) is an imperfect differential. 3

(b) Show that for a thermodynamic system $\left(\frac{\partial P}{\partial T}\right)_V = \alpha E_T$, where α is the coefficient of volume expansion and E_T is the isothermal bulk modulus of elasticity. 2

(c) Write down the Clausius statement and the Kelvin-Planck statement of the second law of thermodynamics and prove that the two statements are equivalent. 2+3

(d) Represent a Carnot cycle on $S-T$ diagram. 1

3. (a) Prove that for a system undergoing isothermal isochoric transformation, the Helmholtz free energy remains constant. 2

(b) If G represents the Gibbs' free energy of a system, show that $C_P = -T\left(\frac{\partial^2 G}{\partial T^2}\right)_P$, terms being usual. 2

(c) State the essential differences between a J. T. expansion and an adiabatic expansion. 2

(d) Deduce the relation :

$$C_P - C_V = -T\left(\frac{\partial P}{\partial V}\right)_T \left(\frac{\partial V}{\partial T}\right)_P^2.$$ From this relation justify that $C_P = C_V$ for water at 4°C. 4+1

4. (a) Using the proper thermodynamic function, deduce the Maxwell's relation : $\left(\frac{\partial T}{\partial P}\right)_S = \left(\frac{\partial V}{\partial S}\right)_P$ 2

Turn Over

(b) The pressure on 100gm of a metal is increased quasistatically and isothermally from zero to 1000 atmosphere. Assuming the density and isothermal bulk modulus to remain constant at the values 10^4 kg/m^3 and $1.50\times10^{11}\ N/m^2$, calculate the work done in Joule. Indicate the significance of your result. 4+1

(c) Write down Clapeyron's equation for the first order phase transition of a system, explaning the symbols used. The density of iodine at the boiling point (185.3°C) is 3.71 gm/cc and latent heat of vaporisation is 40.9 cal/gm. If the boiling point changes by 1°C for a change of pressure of 17mm of Hg, calculate the specific volume of the vapour. Take J=4.18 joule/cal. 1+3

Group - B

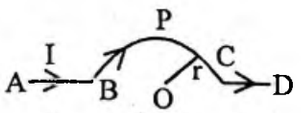
[Electricity - II]

5. (a) State Ampere's circuital theorem and with its help show that $\vec{\nabla}\times\vec{B}=\mu_0\vec{J}$, terms being usual. 1+2

(b) A stationary loop C enclosing a surface area S is kept in a magnetic field $\vec{B}(t)$. Show that the induced electric field $\left(\vec{E}\right)$ satisfies the relation :

$$\vec{\nabla}\times\vec{E}=-\frac{\partial\vec{B}}{\partial t}$$ 3

(c) A uniform wire carries a current I. The portions AB and CD of the wire are straight and the portion BPC is a semicircle of radius 'r' with centre at 0 (see figure). Find the magnetic B-field at 0. 2



(d) Verify that the vector potential $\vec{A}$ due to a uniform magnetic induction $\vec{B}$ is given by $\vec{A}=-\frac{1}{2}\left(\vec{r}\times\vec{B}\right)$. 3

6. (a) A battery of e.m.f. E is connected across a coil of self inductance L and ohmic resistance R. Prove that, after t see, the current will be $E\left(\frac{1-\alpha}{R}\right)$, where $L\ln\alpha+Rt=0$. 4

(b) A capacitor C is charged through a resistance R by a battery of e.m.f. E. The energy supplied by the battery is q_0E (where $q_0=CE$) whereas the energy gained by the capacitor is $\frac{1}{2}q_0E$. Account for the difference in energy. 3

(c) The e.m.f. of a *Cu-Fe* couple working between 0°C and 100°C is given by $E=at+\frac{1}{2}bt^2\ \mu V$.

The constants 'a' and 'b' with respect to a standard metal are given by : $a_{Cu}=2.71\ \mu v/°C$; $b_{Cu}=-0.008\ \mu v/°C^2$; $a_{Fe}=16.7\ \mu v/°C$ and $b_{Fe}=-0.029\ \mu v/°C^2$.

Calculate the neutral temperature, Peltier coefficients and the effective Thomson e.m.f. of the couple. 4

7. (a) What is meant by a magnetic circuit ? Define magnetomotive force and reluctance. 2+1+1

(b) Give the theory of a moving coil ballistic galvanometer and deduce an expression for the transient charge flowing through the galvanometer in terms of the first throw of the galvanometer coil.

What would be the modified expression if the damping correction is incorporated ? 6+1

Turn Over

8. (a) Derive an expression for the instantaneous current in a series LCR circuit driven by a sinusoidal e.m.f. $V = V_0 \sin wt$, terms having usual significance. Define Q-factor of such a circuit. 4+1

(b) Show that the form factor of the waveform $V(t) = V_0 t$ (where V_0 is a constant) for $0 \leq t \leq T$ is $\frac{2}{\sqrt{3}}$, where T is the period of the wave form. 3

(c) How can you produce a rotating magnetic field ? Mention one application of this rotating magnetic field. 2+1
